Electron Cooling Project: status and plans

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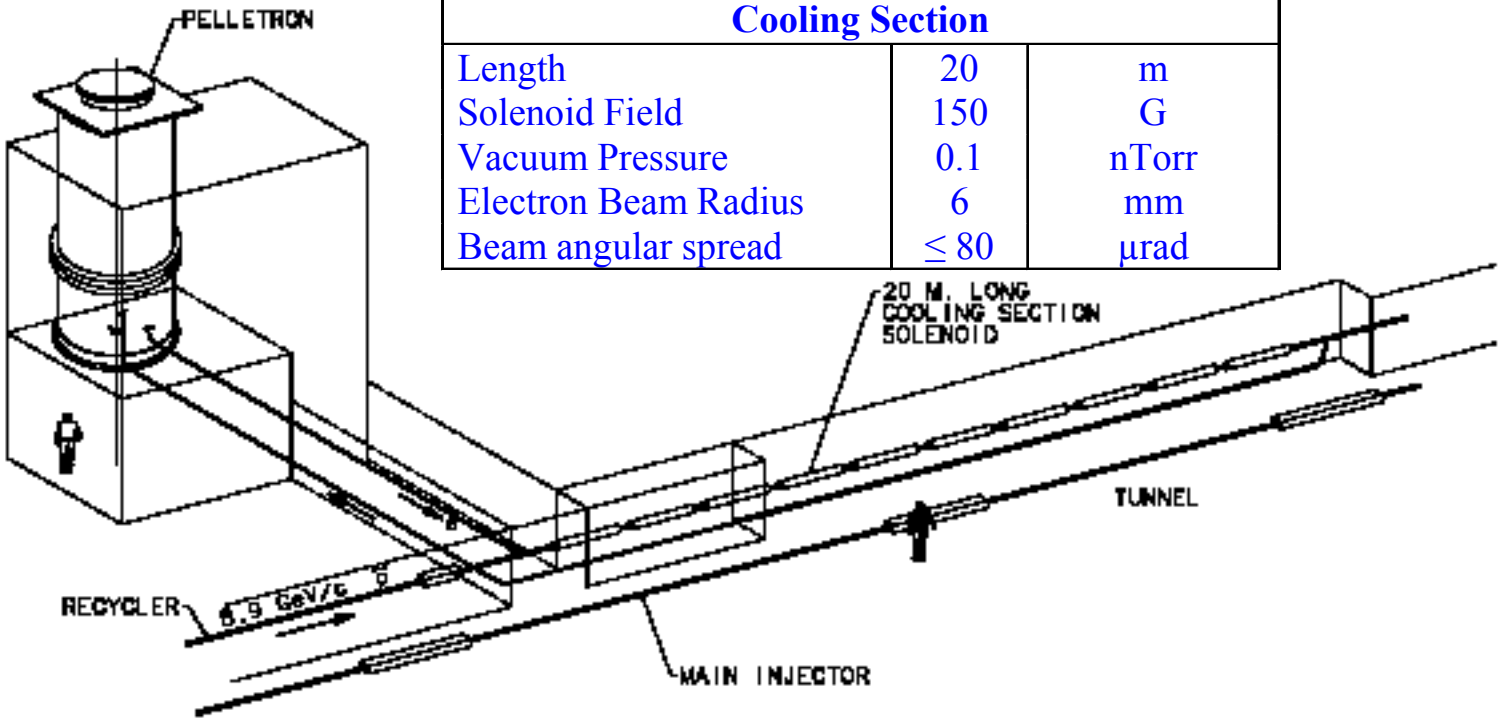
Schematic Layout of the Recycler Electron Cooling

Electron Cooling System Parameters

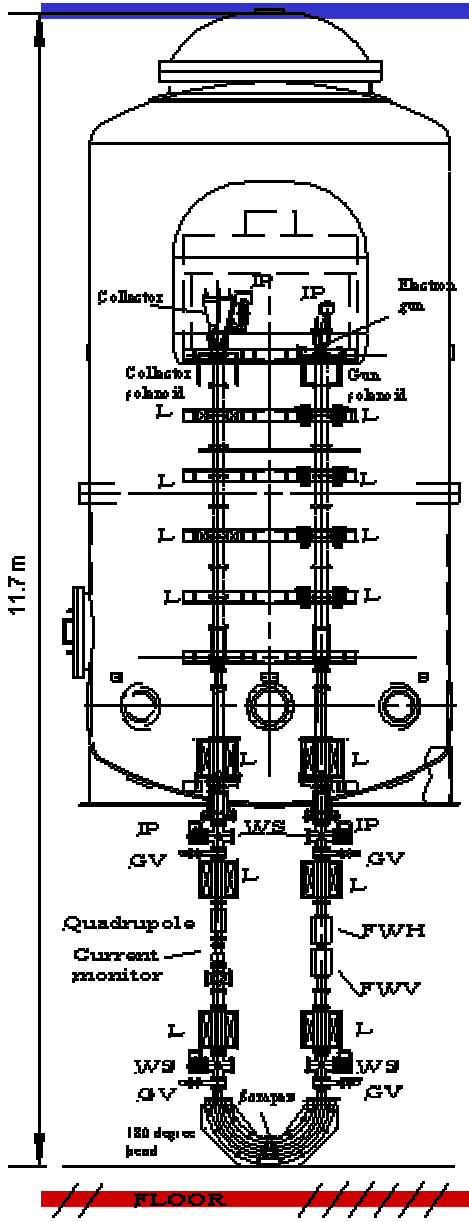
Parameter	Value	Units
Electrostatic Accelerator		
Terminal Voltage	4.3	MV
Electron Beam Current	0.5	A
Terminal Voltage Ripple	500	V (FWHM)
Cathode Radius	2.5	mm
Gun Solenoid Field	600	G
Cooling Section		
Length	20	m
Solenoid Field	150	G
Vacuum Pressure	0.1	nTorr
Electron Beam Radius	6	mm
Beam angular spread	≤ 80	μrad



Stages of the project

- Proof- of- principle experiment at NEC 1995-1999
- Recirculation experiment at Wide Band 2001- 2002
- Full scale beam line at Wide Band 2003-2004
- Commissioning of ECOOL in Recycler 2005

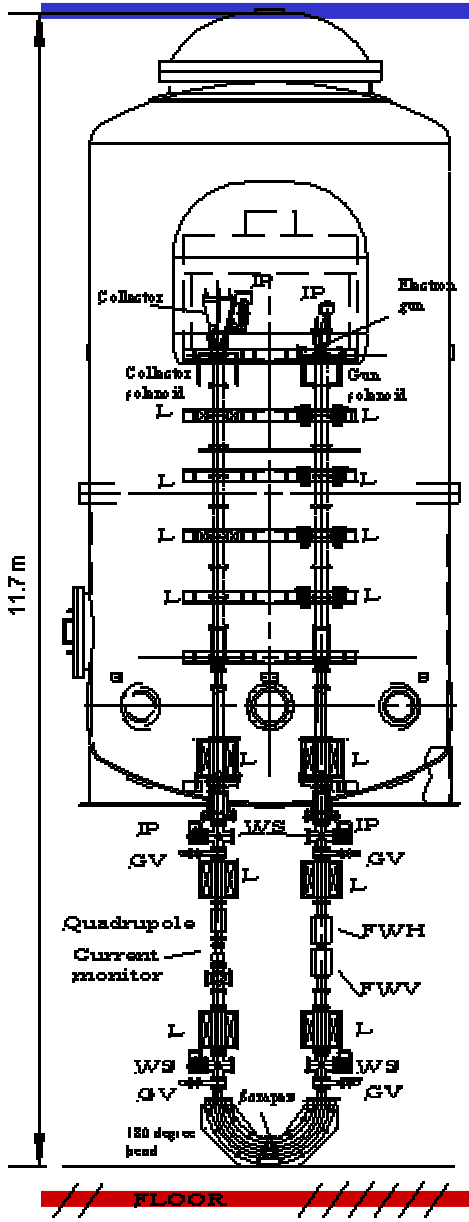
Recirculation experiment at WideBand



HISTORY

Feb 99:	5 MV Pelletron ordered.
Dec 00:	5 MV without vacuum tubes.
Mar 01:	Tubes installed. Operations began.
May 01:	First beam of 30 μA in the collector.
Dec 01:	500 mA at 3.5 MV
Apr 02:	NEC replaced acceleration tubes
Oct 02:	500 mA at 4.36 MeV
Nov 02:	Shut down to install the full beamline

Recirculation experiment at WideBand

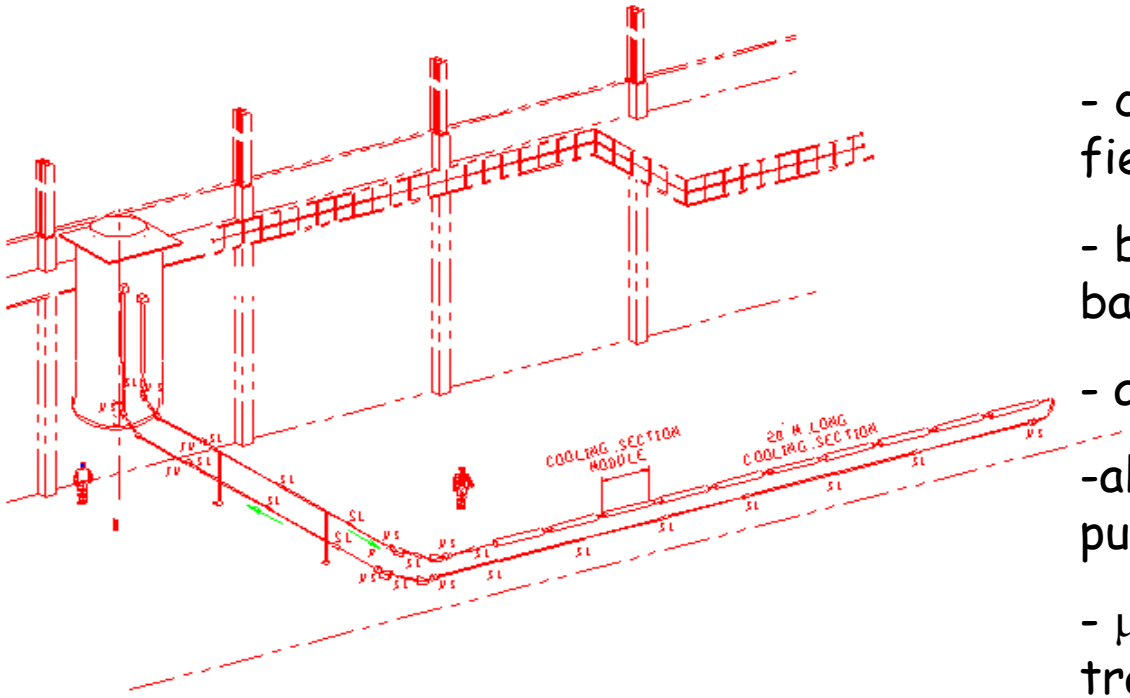


Main results

- Stable operation at 0.5 A, 3.5 MeV (99% duty factor)
- 1.7 A of maximum current at 3.5 MeV (6 MW)
- 0.6 A of maximum current at 4.36 MeV
- Electronics survives sparks

An additional Pelletron section was ordered to be installed in MI 31.

Full scale beam line at WideBand

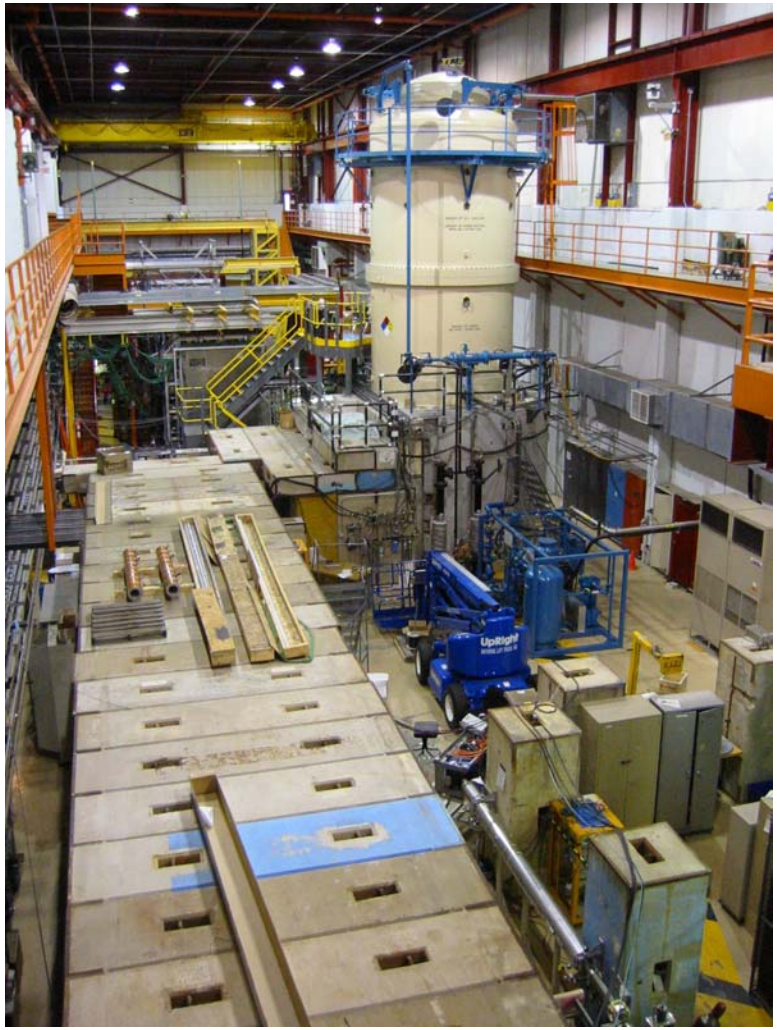


The facility almost replicates the future MI 31 (shorter transfer lines and 9 instead 10 modules in the cooling section).

Current status

- cooling section magnetic fields measured
- beam line assembled and baked
- all diagnostics installed
- all BPMs are tested in pulsed mode
- μA DC beam was transported up to the collector
- trouble spots were identified

Full scale beam line at WideBand



Stages

Low-intensity DC beam	
in collector	Jul 03 √
Final measurements of magnetic	
field in cooling section	Aug 03
Stable 0.5 A at 3.5 MeV	Dec 03
Cold beam at 0.5 A, 3.5 MeV	Mar 04

Cold beam in the cooling section

- The beam center moves along a straight line within 70 μrad. The straightness is controlled by 9 BPMs. The trajectory is adjusted by an entrance angle and by an average dipole field in each module of the cooling section.

- The boundary trajectory doesn't deviate from a straight line by more than 80 μrad in 90% of the cooling section length. The initial tuning of the envelope is done in a pulsed regime with a pencil-like beam. DC beam measurements are done with scrapers.

ECOOL-related measurements in MI/RR tunnel

- Two BPMs have been installed in the Recycler at the future location of ECOOL. BPMs were connected to the final version of electronics capable of simultaneous measuring of electron and pbar beam's positions. Measurements with pbars shown resolution better than 50 μm.

- A 2-m module of the cooling section has been installed in the Recycler at the future location of ECOOL above a MI quadrupole. Magnetic fields in the center of the module in the time of MI ramps are less than 2 mG, which satisfies ECOOL requirements.

MI 31

MI 31 as of July 03

- Construction started in March 03 and is now 20% complete
- Completion is scheduled for March 04
- Additional Pelletron section arrives in January 04